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DIFFICULTIES OF MECHANIZATION IN LESS-DEVELOPED AREAS

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DIFFICULTIES OF MECHANIZATION IN LESS-DEVELOPED AREAS

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1. This paper is based in the main on what the writer has seen for himself, or heard at first hand, during visits to nine less-developed countries in the Middle East, South East Asia, and Africa. In all of them agricultural mechanization of one kind or another has been, or is being, undertaken. In all of them much the same difficulties have been, or will be, experienced. The purpose of the paper is to discuss the causes underlying the difficulties; and to suggest possible ways of alleviating them. In the discussion there will be three distinct aspects of mechanization to consider.

(a) First, there is what may be called "Land-Use Mechanization" - i.e. the use of mechanical equipment for such purposes as clearing new land or reclaiming derelict land; for large-scale soil conservation or the preparation of new irrigation areas. This stands apart because ordinarily the equipment concerned will be too heavy or too specialised for everyday use on the same land afterwards.

(b) Secondly, there is straightforward farm mechanization - i.e. the adoption of much the same kinds of tractors and other modern appliances as are commonly used in more-developed countries; by plantations, estates and such ordinary farm holdings as are large enough to own them individually and use them economically.

(c) Finally, and more importantly in the long run, there is mechanization in the wider sense of whatever can be done to bring mechanical aids to the service of the very small peasant holdings which, in most less-developed areas, will account for the greater part of all farm land.

2. In setting out the background to this discussion it should be noted that in the areas with which this Conference is concerned the two incentives of labour shortage and rising labour costs, which have mainly conditioned the development of mechanization elsewhere, will not ordinarily exist. Only rarely will there be any general scarcity of workers; more commonly they will be plentiful enough to make fears of unemployment something of an obstacle to the whole idea of mechanization. Nor, where family farms operating at or near the subsistence level are likely to predominate, can labour costs have very much significance. At least, so far as this generation is concerned, anything like widespread mechanization of the agriculture of less-developed areas can be justified, if at all, only by increased production of food or fibre.

3. One obvious instance is the land-use mechanization already mentioned, much of which aims ultimately at increasing the effective area of farm land. Over the last fifteen years in India, for example, some hundreds of thousands

of acres, derelict through complete infestation with rhizomatous weeds, have been brought back into cultivation by deeper ploughing than could be done without mechanical power. But in most countries the areas which can be developed at all economically as entirely new farmland are relatively limited; while reclaiming derelict land raises immediately the problem of keeping it productive afterwards. Almost everywhere a far greater potential opportunity will lie in overcoming whatever factors may limit productivity on the land that is already in cultivation.

4. Some factors like poor seed, lack of chemical or other manures, and inadequate crop protection which are known to limit productivity have nothing directly to do with mechanization. On the other hand, particularly under monsoon conditions in which all the work of soil preparation and seed sowing has to be crowded into a few weeks following the rains, one major limiting factor is the very low work output of the typical team of draught animals. Their pulling ability is poor, they are slow-moving both in getting to and from their work and in the work itself, and they need to stop frequently for rest or watering. In consequence the whole useful output of a peasant's pair of bullocks is probably no more than four or five horsepower-hours a day; and, in what is necessarily a short working season, this is very often not enough for what needs to be done.

5. The weed-derelict land already mentioned is itself evidence of the outcome in some areas. The weeds in question - Kans grass, Harialı and Kundah - all spread from one field or farm to another by seeding; and it is only after they have established themselves that specialised equipment is necessary to get rid of them. In their early stages they can be controlled, and by farmers with resources enough are controlled, by thorough and timely working with whatever indigenous tillage tools are ordinarily used. But the work falls to be done in the same brief period following the rains; and, where cultivators face the short-term alternative that their families will go hungry if crop sowing is delayed, is likely not to be done thoroughly enough.

6. Nor are the limitations of draught animals confined to the districts in which weeds like these are prevalent. Around almost any peasant village, and in almost any season, one can see pieces of land lying idle which, given more time or more power, would have been under crop. On cropped land one can see poor crops resulting from late sowing. Again, in many areas with ample water for irrigation, the fact that only a small proportion of the land is double-cropped results from the same basic cause.

7. Against this background the difficulties of mechanization are all, in the final analysis, economic. There is indeed only one all-embracing difficulty; that in less-developed areas mechanization costs too much. On the one hand, there are the relatively high capital costs of equipment which limit individual ownership to a very small proportion of farmers. On the other, there are the excessively high operating costs arising from inefficient usage, high incidence of breakdowns and repairs, and too rapid depreciation of machines. Alongside these there is very commonly the complaint that the service and repair facilities offered by local agents and distributors are inadequate.

8. The difficulty of providing equipment cheap enough for small-scale farmers to own for themselves exists wherever mechanization is in its early stages. In the past it has existed in all the countries in which mechanization is now well advanced; in some of them, where more elaborate

appliances for saving hand labour are concerned, it still exists. But in these more-advanced countries, what is the real core of the difficulty from the standpoint of less-developed areas - to provide small farms with tractors so as to replace animal power - has tended to resolve itself by what may be called mechanization from the top downwards.

(a) What has happened in the United Kingdom provides one illustration. The main feature of downwards mechanization is that tractors and tractor implements which become obsolescent on the large farms which first buy them are passed down to smaller ones. They are "traded-in" as part of the purchase price of newer ones; and then, generally after reconditioning, are resold, second-hand but still thoroughly serviceable, at prices well below their original cost.

(b) But in the United Kingdom at the outbreak of war, when by present standards mechanization was only just beginning, there were already 50,000 tractors, or roughly one to every 250 acres of arable land; while five years later, and as a direct consequence of the war, there were three times as many. In the meantime, ideas on large-farm mechanization had developed very considerably: the tractor was no longer only, or even mainly, a source of pulling power. In addition to pulling, it was required to operate an ever-widening range of labour-saving appliances as soon, following the removal of wartime restrictions, as these became readily available.

(c) There was, therefore, a great urge among large-scale farmers to replace existing tractors by more modern ones; and there were readily available large numbers of less modern ones to be disposed of. Today, largely as a result of this, even the smallest of U.K. farms use mechanical power almost exclusively.

9. In the foreseeable future this process of mechanization which is self-inspired downwards cannot be expected to happen at all similarly in less-developed areas. Relatively to the total area of farmland, the numbers of tractors and tractor implements in large-scale farming will be far too small; while the numbers of very small farms will be far too great. Moreover, as a result of the rapid depreciation already mentioned, the useful life of machines will be so much shorter that second-hand ones which are still truly serviceable will be something of a rarity. It follows that if, in line with what has generally been the rule elsewhere, less-developed countries confine their encouragement of mechanization to farms and other enterprises large enough to accept it as it stands, and leave further extension to natural economic development, the impact of the process on overall food and fibre production, and on general standards of living, will for a long time to come be very small indeed.

10. The circumstances which lead to high operating costs are to be found almost inevitably wherever mechanical equipment is newly introduced: in state-controlled land-use mechanization and private farm mechanization alike. In the past they, too, have existed in greater or lesser degree wherever farm mechanization is now well advanced. Indeed, as recently as twenty years ago, when wartime food production efforts suddenly brought tractorised equipment to grassland areas unaccustomed even to horse-drawn ploughs, they were something of an embarrassment in the United Kingdom. They are the result simply of lack of experience and "machinery-mindedness"; and can be overcome only by education and practical training at all levels from tractor drivers and mechanics upwards.

11. In many less-developed countries there are now reasonable facilities for training drivers and mechanics; but there is at the same time a high wastage of trained and semi-trained men to road transport and other non-agricultural occupations. There are also increasing facilities, both in local colleges and through overseas studentships, for training men at or near graduate level; but most of the men so trained go afterwards to administrative posts too far removed from the everyday problems of farming. Nor is this always the fault of the authorities responsible for directing them: on one recent occasion a Prime Minister addressing a batch of agricultural students about to go overseas for training was heard to warn them not to come back feeling too "educated" to work in the field.

12. Between these extremes there is a wide gap. Hardly anywhere in these areas is there anything like an adequate supply of what, in army parlance, may be called the non-commissioned officers: men practical enough to improve machinery usage and management by direct example; and yet knowledgeable enough to influence decisions on such matters as choice of equipment and organization. To make provision for filling this gap by specific training is not at all easy: most of the essential attributes can be developed only through practical experience.

13. Complaints about the service and repair facilities offered by agents and distributors in less-developed areas are often well-founded. Almost everywhere service standards fall well short of those to which farmers in more highly mechanized areas are accustomed. But everything necessary for giving good service - representatives and mechanics, their transport and workshop equipment, along with the costs of maintaining adequate stocks of spare parts - has to be paid for out of whatever profits can be earned by selling machines. And so long as relatively few machines are scattered over relatively large areas; while, for one reason or another, the incidence of breakdowns is higher than it should be; the costs of giving prompt attention to customers' difficulties will tend to be prohibitive. Everyone will have heard stories of service vans and mechanics being sent a hundred miles to deal with emergencies which turn out to be no more serious than a choked jet or water in the fuel. At least in principle, most of them are true. Given the most competent agents imaginable, the effectiveness of service arrangements will still be in some kind of proportion to the density of machines on the ground.

14. The conclusion to be drawn from the service angle - that only more mechanization will lead to better mechanization - also has a bearing on the other 'usage' difficulties that have been mentioned. In an atmosphere of expanding mechanization all of them will tend to be alleviated. Tractor drivers and mechanics will see better prospects of advancement, and will be less likely to leave agriculture for other occupations. Men trained at graduate level will have more sense of purpose, and be more conscious of the opportunity to make good use of their talents outside purely administrative posts. Many more of what have been called the non-commissioned officers will emerge automatically. Above all, everyone concerned will have far greater opportunities to learn by example. Over the years British farmers have learnt more by what is commonly called "looking over the hedge" than by any other means.

15. To discuss social or political questions, or even to advocate widespread agricultural mechanization, is outside the scope of this paper. It does, however, seem certain that, among other ways of overcoming these present difficulties, less-developed countries will look increasingly to the use of mechanical power in farming. They must, therefore, seek means to encourage mechanization in at least this simple sense on holdings smaller, and perhaps very much smaller, than those now commonly involved. In India, which is chosen as example only because statistics [1.] are readily available, only one third of all farm land is in holdings of 25 acres and over, while more than a third is in holdings of under 5 acres. Later in this paper what may be called organizational methods of extending mechanization; including such measures as the setting-up of contracting agencies, or the encouragement of co-operative machinery usage; will be discussed. In the meantime another possibility, the provision of less-costly equipment, must be considered.

16. At present practically all the equipment of mechanization comes from manufacturing countries in Europe and America; and, from the standpoint of most less-developed countries, it would be unrealistic to suggest that this can change at all markedly in the foreseeable future. But none of the manufacturing countries, nor yet any individual manufacturer, has so far designed or developed ordinary farm tractors specifically for export. Subject only to quite minor modifications, the design of all those they send overseas is conditioned by the requirements of their home markets.

(a) But in these same countries the appliances of mechanization have had continually to be extended and elaborated to keep pace with the consequences of industrialisation. New or expanding industries have drawn more and more workers from the countryside; higher wages and living standards in the towns have brought ever-increasing demands from those who still work on the land. To reduce labour requirements to a minimum in every aspect of farming has become a controlling factor in the development of all farm machines.

(b) As a result of this, present-day tractors have been a great deal elaborated even by comparison with those of, say, twenty years ago. Instead of 3 or 4 gears, they now have anything from 6 to 10; features like steering brakes, adjustable wheeltracks, live power take-offs and differential locks which, if available at all, used to be optional extras have become standard equipment. On top of all this, but for no very logical reason, ever more elaborate styling has come into fashion. Models equivalent to those with which countries whose methods are now well advanced started farm mechanization are no longer manufactured.

17. Apart from styling, which is of no great practical use to anyone, most of the elaborations just mentioned are concerned in one way or another with saving manual labour: that is, with an aspect of mechanization with which, at the outset, less-developed areas will not be greatly concerned. In present circumstances most potential tractor users in these areas could manage without them, and perhaps would willingly do so if they could save money thereby. Against this, manufacturers would no doubt argue that in highly-automated mass-production - without which the tractors would be still more costly - little, if any, saving of money results from leaving things out. Against this in turn, the present writer would be inclined

(1.) India 1960. Publications Division, Government of India.

to re-argue that every elaboration makes the tractor more difficult to understand and maintain in good order; and that, even if their omission saves no money, most potential users in less-developed countries would be better off without them.

18. To look at this question more rationally: at present perhaps nine-tenths of all tractor sales are made in countries with highly sophisticated farming systems. Quite rightly, therefore, from the manufacturers' viewpoint, design and production policies are dictated by the requirements of these countries. On the other hand, it is quite certain that if the essential requirements of less-developed areas were studied, with no reference at all to more sophisticated requirements elsewhere, one outcome would be a specification for a potentially simpler and cheaper tractor.

19. The one reason why this has not been done; or, if it has been done, why nothing practical has resulted; is that the potential 'live' market has never looked large enough to justify the very high investment in completely new tooling that would be needed. Yet, undeniably, if some compromise between all the conflicting viewpoints could be reached, the potential market is a very substantial one.

(a) In a study of agricultural mechanization in the Indian economy,[2] for example, Behr suggests that farms of 25 acres and over are large enough to permit efficient capitalization including especially the individual purchase of tractors. He considers, too, that in most cases the farmers concerned would actually have money enough. However, if only half of them were in this position, but there were no other barriers, there would be an immediate outlet for more than a million and a quarter tractors.

(b) How far India is at all representative of less-developed areas in general is open to question. Elsewhere, in relation to area, corresponding estimates might be less optimistic. Nevertheless, the estimate just given for India alone would absorb Britain's total tractor exports for a period of six or seven years; and, at present, Britain is the world's largest exporter. It must, however, be remembered that British farmers with no more than 25 acres would be unlikely to start off by buying new tractors: as indicated earlier, reconditioned second-hand ones would be the more general rule. Nor, so long as present specifications and prices persist, is it likely that 25-acre farmers in India will do so.

20. At this point it should perhaps be mentioned that in Britain the supply of second-hand tractors filtering down from large farms already exceeds the demand from smaller ones. The surplus, amounting to three or four thousand units a year, is exported. So far as is known, none of these tractors yet go to less-developed countries: the main outlets are in near-by countries in which mechanization is already well-advanced, but in which tractor populations are still rising. In time much larger surpluses of still-serviceable tractors may become available from other countries beside Britain. In theory, therefore, this may represent another possible source of cheaper power units for less-developed areas.

(2.) Behr, A.P.B.G. The place of agricultural mechanization in the Indian economy. Proceedings of the Institution of Agricultural Engineers, London. Vol. 17, No.1 (1961).

(a) At present, and for two reasons, second-hand tractors can be exported in comparatively casual fashion: in the receiving countries all the services necessary to support mechanization are well-established; while the numbers concerned represent only a small proportionate addition to the existing tractor population. Not all the tractors go through regular distribution channels; some are sold in "off-the-farm" condition, the customer taking responsibility for any reconditioning that may be needed. Exports to less-developed countries would obviously need to be backed by some more elaborate organization.

21. The kind of tractor that the writer has in mind, as the possible outcome of new thinking on the lines indicated in paras. 17-20, is not something essentially new. Most probably the outcome would be a tractor not very different from one or other of those that were current thirty or forty years ago. Subject only to the difficulty of getting manufacturers to look at the situation seriously, and without too much regard for their present more sophisticated markets, it is, therefore, a quite practicable proposition. At the same time, even if the resulting selling price was no more than half that of the tractors current today, it would still be too high to permit individual ownership by the majority of peasant land-holders. Accordingly, and recalling the circumstances outlined in paras. 4-6, a still less ambitious approach may be considered. To overcome the limitations then outlined would need nothing more in principle than the mechanical equivalent of a rather stronger, faster-working, bullock team. Indeed, if such an equivalent was capable of pulling only the same indigenous implement as a pair of bullocks do now; but could at the same time carry the man using it, and keep moving at, say, 2½ miles an hour; it would have more than twice their useful work output. A very small and simple power unit, somewhat in line with this conception, has recently been developed at the National Institute of Agricultural Engineering; and is to be described in another of the papers 3. to be read at this Conference.

22. Whether a very small and simple tractor would, in fact, prove to be practicable has been discussed by a number of different authorities over the years. In particular, Hawkins, 4. whose wide first-hand experience lies mainly in areas with which the present writer is unfamiliar, considers that it would be found to be impracticable because, as the result of modifications during its early trials, it would inevitably grow into something which would be no more than a smaller version of the standard models now available. In order to pull even a single-furrow plough in hard land it would need to be able to exert a drawbar pull of at least 1,000 lb.; and should be capable of doing this at altitudes up to 5,000 ft. It must be robust enough to withstand rough usage on only partly-cleared land; it will need to have a belt pulley to provide power for pumping, grinding and threshing; and so on. There is some justice in these objections: throughout tractor history there has been a tendency for small tractors to grow larger so as to widen their potential market. There are, nevertheless, vast areas not much above sea level, and unencumbered by tree-stumps or boulders, waiting for a cheap enough means of mechanical cultivation. Nor is there everywhere the need to pull a turn-furrow plough.

(3.) Cashmore, W.H. The development of agricultural equipment for use in the less-developed areas.

(4). Hawkins, J.C. From man-power to machines. World Crops, Vol.13, Nos. 8 & 9 (1961).

23. Arising from the last point, one very obvious cause of high operating costs is that practically all the implements which accompany tractors to less-developed areas are quite strange to those who use them. A familiar example, which must already have cost large sums in repair costs, is the multi-furrow plough which is turned around at the end of the field without being lifted out of work. This kind of mis-use is very difficult to eradicate. If tractor implements followed the pattern of indigenous ones more closely a great deal of misunderstanding, and need for re-education, would be avoided. So far as is known, 'tractorised' indigenous implements do not exist anywhere; while instances in which there is firm evidence that agronomic advantages result from using non-indigenous ones are remarkably few. There are, on the other hand, some notable exceptions to this; including the method of tied-ridge cultivation, for marginal land in semi-arid regions, with which Hawkins himself has been largely concerned.[5.] This certainly could not easily be applied without something very close to a conventional tractor.

24. Finally, it would be wrong to close this discussion of the possibility of providing less-costly equipment without some mention of two-wheeled 'walking' tractors. They are of the same order of cost as the still-hypothetical very small 'riding' tractors would be; and are already available commercially. Also, in modest numbers, they are already exported, mainly for small-scale paddy cultivation, to less-developed areas. But they are essentially garden cultivators designed in the first instance for intensive market gardening in temperate climates, or for use in private gardens in urban areas; and it is questionable whether, if the needs of less-developed areas had been the sole consideration, they would have come into existence at all. To handle a two-wheeled tractor throughout a full day's work would tax the strength of a fit, well-fed man anywhere; and would probably be out of the question for those who are less well-fed, and work in tropical or sub-tropical climates. This kind of equipment is to be regarded as a possibly useful adjunct to mechanization in less-developed areas, rather than as an effective means of extending it.

25. No method of providing less-costly equipment can come to fruition within a period of several years; while of those that have been mentioned neither the organised supply of second-hand tractors, nor the production of simpler versions of conventional tractors, would by itself do anything to help very small farms. Whether the third method, the development of simple bullock equivalents, is practicable at all is problematical. For some time to come, therefore, and perhaps for all time, what have been called organisational methods of bringing mechanical power to the aid of very small-scale farming are likely to be of more general consequence. The range of activities that this description might cover is a very wide one, ranging from Government organisations with large fleets of equipment to village enterprises perhaps with only a single tractor. Of the schemes of one kind or another that have operated so far, some have failed altogether; while some others, at least in terms of sheer physical accomplishment, have been highly successful. But, if all overhead costs are included few, if any, have been economically successful in the sense that the work has been done at a cost which peasant farmers could afford to re-pay in full. This, nevertheless, must be the ultimate aim.

(5.) Cashmore, W.H.; Hawkins, J.C. Tillage Equipment and Soil Conservation. Proceedings of the Institution of Agricultural Engineers, London. Vol.13, No.1 (1957).

26. If, while seeking to make use of mechanical power, very small farms are to preserve their independence - i.e. to be able to grow what they like, when they like - they must either hire tractor services or share them. Even then, because the equipment will be working in small and perhaps badly-shaped fields, and will have to move frequently from one field to another, work output will be lower and operating costs higher than they would otherwise be. On the other hand, if some measure of independence can be given up, there are the much wider possibilities that would arise from regrouping farms, field, or even crop rotations. To deal with these at all fully would involve social and political questions which the writer is not competent to discuss. Mention of one or two instances in which something of the kind has been done will, however, be useful.

27. Of all the ventures in less-developed countries, in which mechanization has played an essential part, the most outstandingly successful has been the now well-known Sudan Gezira Scheme.[6] This started with the building of a dam, and the constructors of all the works necessary for a very large-scale system of canal irrigation. This by itself meant introducing some kind of order into an area in which farming, up till then, had had no pattern at all. In fact the re-patterning went well beyond what was necessary from the irrigation standpoint alone: the whole system of land-tenure was modified so as to allow all basic tillage to be mechanized.

(a) All the land was compulsorarily purchased; the original owners being given preference in the subsequent allotment of tenancies. Within an overall pattern, which need not be described here, the land was then divided into "fields" of the order of a hundred acres, which rotated annually between cotton, the main cash crop; food crops for men and animals; and fallow. Tenancies are on an annual basis: each family holding consisting of so much land in a cotton block and so much in a food-crop block. With this arrangement all major operations, like ploughing or special methods of weed control, can be done with large-scale equipment at a price which individual cultivators can afford. The area concerned on any one occasion is always large enough.

(b) The Gezira Scheme started under a Colonial Administration; and, in this and other respects, the circumstances which have favoured its success may not now exist anywhere else. Nevertheless, two major results of the original scheme should be mentioned. The first is that although, at the outset and for years afterwards, the Scheme depended very largely on the services of expatriate staff, it now operates just as smoothly, and has recently been extended quite considerably, with an entirely Sudanese personnel. The second is, that as a direct outcome of the Scheme, most of the tenants have become highly prosperous. In many cases they and their families are now too prosperous willingly to go cotton-picking; so that labour shortages are arising.

28. Another instance, already briefly mentioned, is the reclamation of weed-infested land in India by the Central Tractor Organization. This started soon after the war with the gift of about 300 heavy crawler tractors left behind by the American Army. At that time, and even in countries

(6.) Ferguson, H. The Gezira Scheme in the Anglo-Egyptian Sudan. World Crops. Vol.4, Nos. 1, 2 & 3 (1952).

much nearer possible sources of supply, spare parts of any kind were difficult to procure; and, through the need to set up workshops for making them, the Scheme had to bear a heavy burden of overheads almost from the outset. The work was highly seasonal: effective weed-killing being possible only during about six months each year. At first, efforts were made to extend the tractors' annual period of activity by using them also for land clearing, but this cost too much in machinery repairs. The equipment as a whole was, of course, too heavy to be used in anything like ordinary farm operations during the off-season.

(a) The work was organized on a grand scale with teams of 8 or 10 heavy tractors ploughing areas of several thousand acres in one piece. The land, although derelict, was still owned by individual cultivators in the familiar pattern of odd bits and pieces. Compulsory powers of some kind had, therefore, to be used to provide large enough reclamation areas. Immediately afterwards, however, the land reverted to its original owners.

(b) No single operation can be expected to eradicate weeds like Kans grass completely: some viable fragments will remain and, from these, after three or four years, the weeds, too deeply-rooted to be controlled by animal-drawn tools, will begin to reappear. For this reason there arose the need for follow-up tractor operations, generally done on smaller scale by more localised Government agencies. But the scale was still far too large for the ploughing of one- or two-acre fields to be practicable. It was, therefore, necessary to persuade individual cultivators, some of whose own fields might not yet be badly infested, to fall in with their neighbours, so as to provide areas large enough to work in.

29. Although rather far removed from our main theme, these two instances illustrate points which have much wider application. Wherever, perhaps as a consequence of land-use mechanization, completely new areas become available for cultivation, layout on something akin to Gezira lines should be practicable, and would greatly facilitate mechanization. Moreover, this would be true whether or not irrigation was involved, and even if the area of land to be dealt with was very much smaller. Indeed, given only willingness to co-operate over land re-distribution, much the same principles might be applied to areas of only a few hundred acres. Alongside this, the C.T.O. activities illustrate the kind of way in which land-use mechanization measures tend to throw up a need for smaller-scale mechanization afterwards. This instance also raises the question of whether, even in a job of this magnitude, a smaller-scale approach with less elaborate equipment might not be ultimately more rewarding. As things actually happened both the equipment and the initial scale of operations were dictated by circumstances - i.e. a legacy of several hundred heavy crawler tractors. Otherwise, the job could almost certainly have been done with something simpler, e.g. with wheeled or half-track tractors pulling only single-furrow ploughs. In this case it is likely, but not at all certain, that the first ploughing itself would have cost more. But against this, it would have been far easier to utilize the equipment more fully; follow-up cultivations would have been easier to organize; while the broad educational results would have been far greater. Large crawler tractors are so far beyond the most optimistic aspirations of a small farmer that, even where used on his own land, they teach him little or nothing about mechanization.

30. In the writer's view, this last point is a most important one. Almost universally with mechanization ventures in less-developed countries the degree of success or failure is determined very largely by whether or not enough trained or experienced men of the right calibre are available. Particularly where small-scale mechanization is in question, conventional training facilities like those already mentioned in para. 11, are not a complete answer. There will rarely be enough of them to reach individual small farmers; and there are qualities to be developed which they hardly touch. For this reason, wherever there were two alternative 'mechanization schemes' to choose from, the writer would prefer whichever was more likely to develop, or bring out, the abilities required. Just what is meant by 'men of the right calibre' is difficult to define, but actual examples can be given.

(a) In one instance, in which ploughs were being wrecked by turning without lifting, the man in charge was quite aware of what was happening; and said that he had often enough exhorted his tractor drivers about it. What he had never done, or thought of doing, was to go into the field, turn a driver off his tractor, and show him there and then how the job ought to be done.

(b) In another instance, and in another country, what was described as a successful co-operative scheme was inspected. Two tractors and a modest complement of tillage tools had been put at the disposal of a small village along with a man to take charge of them. Most of the equipment was on its last legs; but this was mainly because there were no near-by facilities for anything like thorough overhaul. The man in charge appeared to be technically competent, and day-to-day maintenance seemed to have been reasonably good. In effect, therefore, the equipment had worn itself out more or less legitimately. But as closer enquiry showed, it had worn itself out almost entirely in the service of the local landowner who himself farmed a few hundred acres: the villagers had hardly had sight of it.

(c) In yet another instance, four government-owned crawler tractors with multi-furrow ploughs were engaged in ploughing, all in the same field. Each driver had made his own 'start' quite independently of the others; and no two of them were anything like parallel. The final outcome was chaotic. When criticised about this, the man responsible for the work - in an office some miles away - said that the four men concerned were all 'graded' tractor drivers, and all equal, so they should have sorted things out for themselves.

31. These examples have been chosen from others that might have been given because they illustrate the qualities like integrity, willingness to demonstrate by example, and ability to organize field-work, which most conventional training fails to develop. All the men concerned had actually been trained at either graduate or lower level. The examples also illustrate the need, already mentioned, for non-commissioned officers. Training of a rather different kind is now being given, under the auspices of the Central Treaty Organization at a centre in Iran.[7] This has been operating only since the latter part of 1961, so it is too early to judge how far it will provide what has been lacking hitherto. However, since the writer was one of those responsible, after a lengthy tour of the Region, for recommending that the Centre should be established, the ideas behind it can be outlined.

(7.) Agricultural Machinery and Soil Conservation. Training Centre, Karaj, Iran.

32. The broad intention was to train men who could afterwards be competent to serve as 'project leaders' in any kind of activity which involved the use of tractors and associated farm machines. Alongside more general tractor usage, soil conservation was to be given particular attention because often enough soil conservation measures are the first kind of activity to bring tractor equipment into particular areas. Students would be eligible for entry only if they had already been trained at graduate level in agriculture or engineering. The course, including a leave period, was to last a year; but new entries were to be taken every six months so that at any given time there would be junior and senior classes under instruction. Against a background of appropriate theoretical teaching, practical instruction was to be directed mainly in four directions: everyday care and maintenance of equipment; adjustment and setting of implements in the field; layout and carrying out of field-work; and the organization of all these things together in field projects.

(a) The main novelty of the scheme lies in the way in which practical instruction was to be given. There were to be tractors, implements and land enough for each junior student to engage in actual tractor operation for some hours every day. At any given time each tractor, along with an associated implement, would be definitely assigned to a particular student who would be entirely responsible for looking after and using them. In the early stages of training, things like tractor servicing or the inspection of implements after work were to be taught as a regular 'drill': students being required to do them as a matter of routine every morning and evening whether they were actually necessary or not.

(b) Another unusual feature was that there was to be a bare minimum of instructional staff: perhaps, apart from two or three lecturers in background subjects, only one man in general charge of all maintenance and repairs, and another in charge of all field-work. Detailed instruction was to be given as far as possible by the Senior Class largely on a man-to-man basis. There was also to be a bare minimum of labourers and mechanics: as far as possible all actual work on the land, or in the workshop, was to be done by the students themselves.

(c) In addition to acting as part-time instructors, the senior students were themselves to receive more advanced training, e.g. in land surveying, the planning and lay-out of soil conservation measures, and in organizational methods. Nor was the reason for using them as part-time man-to-man instructors an economic one. The aim was to turn out men so well drilled in good machinery habits that they could not afterwards tolerate bad ones without taking a direct hand to put things right.

33. After many digressions we come now to the real core of the problem: to find means to bring mechanical power to the aid of small farms as and where they exist at present. In broad terms, the answer has been given already: small farmers must either hire the services of tractors or share them. The subject has been widely discussed over the years, and is among those dealt with, from two quite different viewpoints, in papers already quoted.[2,4] From all discussions alike three main possibilities emerge: the establishment of government contracting services; the encouragement of 'village' contractors; and joint machinery ownership by groups of farmers.

34. By government contracting services is meant essentially services which are administered from a central headquarters and which operate over a fairly wide area: e.g. over a radius of, say, 15 miles or more. They are in fact called 'government' services only because no purely commercial agency has yet undertaken anything of the kind in less-developed areas. Reference to several existing schemes is made, along with a great deal of useful comment, in a symposium on mechanical cultivation in Uganda. 8.

(a) No government contracting service has ever yet proved to be economically viable on its own account; nor is this wholly, or even mainly, because government activities inevitably incur high overhead costs. In most of the instances in which factual costs have been published overheads of this kind have been omitted: even so, the cost of the work done has always been more than most small-scale farmers could afford. The real reason why contract services are uneconomic is that the individual jobs to be done are too small and too far apart: men and equipment spend too much time travelling, and too little at work. In Uganda, for this reason, it is suggested that a farmer with only 2 acres to be ploughed, should be charged twice as much per acre as one with 20 acres.

(b) Efforts to overcome this difficulty by more rational work planning very often defeat themselves. For example, when the work of a particular output is being arranged, within a total tour of, say, 20 miles, there will be points at which several individual jobs are within half-a-mile or so. It is then good planning to arrange that, when the tractor reaches a point like this, it stays there to complete all the near-at-hand work before moving on. But very often the result will be more urgent work, which happens to lie farther on in the tour, will be delayed. Again in Uganda, dissatisfaction arising in this way is a main reason why many first-year customers do not re-engage contracting services in the subsequent year.

(c) One possible way out of this dilemma is Group Contracting. This means roughly that unless, in a given district, there are enough interested farmers to provide a worth-while area of work, the tractor will not go there at all; and that, wherever it does go, the work will be done for, and charged to, the whole group of farmers. But wherever group contracting is practicable, circumstances would favour one or other alternative to government contracting equally well.

35. Against this, the alternative of encouraging village contractors is an attractive one. Here the broad idea is that one man, perhaps himself a small farmer, would buy a simple set of equipment to undertake, on purely commercial lines, work for his neighbours. Overhead costs, apart from interest and depreciation, would be at a minimum; the work would lie close at hand; and, because the man's own financial well-being would be at stake, the equipment would be well cared-for.

(8.) Symposium on Mechanical Cultivation in Uganda. Department of Agriculture, Uganda (1960).

(a) Wherever village contractors establish themselves, their contribution to the solution of the whole problem will be most valuable. But of those who favour this alternative few, if any, seem to think that one-man contractors will emerge spontaneously. They envisage, in fact, that some agency, perhaps a local government authority, will select a suitable man; train him for his job; provide credit facilities to help with the purchase of equipment; and, at least until the cost of the equipment has been fully repaid, supervise his activities. The one likely shortcoming of the village contractor is that, with the need to make the venture a commercial success always in mind, he would tend to neglect very small-scale holdings in favour of larger ones.

36. The one commonly-expressed objection to the third alternative, joint machinery ownership, is that farmers are notoriously bad co-operators. Against this it could be argued, that in most less-developed countries, villagers and other rural dwellers are already more dependent on one another than they commonly are elsewhere. It could also be argued that practically everything apart from mechanization that could or will be done to raise living standards in rural areas will have to be organized, in one way or another, on a community basis. In some areas at least, therefore, circumstances more favourable to joint machinery ownership are likely to arise automatically.

37. Granted that the only form of government contracting likely to succeed is group contracting; and also that to avoid chaos in joint machinery ownership, there must be one man, or one man per tractor, to operate and service the equipment; the practical differences between these three approaches are probably not as great as they may appear. With all of them alike there must be (1) a reasonably compact area to be served; (2) equipment which is adequate, but not overelaborate, for the purpose; and (3) skilled men at the rate of at least one per tractor. Also, somewhere in the background, there must be adequate facilities for repairs and spare parts. If these facilities are lacking, or if the men operating the equipment are not good enough for this job, the scheme will fail regardless of who nominally employs them or who plans their work. In any case, hardly anywhere is there a firm enough basis of actual experience to guide choice between one scheme and another. The most that anyone could recommend with confidence would be the setting-up of pilot schemes.

38. Behind the whole of this paper lie three firm convictions: that low-level farm mechanization will be necessary, sooner or later, in most less-developed countries; that, in accomplishing this, training in its broadest sense will be by far the most important issue; and that the need for simpler and less-costly equipment is not only a very real one, but is one which, given only a sufficient interest by manufacturers, could actually be met. In the light of these convictions, and of the preceding paragraph, it is proposed to end by indicating lines along which practical training and a multi-purpose pilot scheme might be combined in a way which might also attract the direct interest of manufacturers. To avoid repetition it is assumed that the kind of practical training to be given would be similar to that already described at some length in paras. 31 to 32 (c).

(a) Necessary requirements in any training venture are students and instructors; facilities for housing and feeding them; and training equipment like tractors and what goes with them. In what is now proposed all these would be located in an area of small-scale farming, reasonably well suited to low-level mechanization; while practical field training would be associated, as closely as possible, with the provision of contract services for neighbouring farmers or groups of farmers. Once they were capable of driving a tractor junior students, at first with a senior student beside them, would get further training and experience while actually doing a real job on a farmer's own land.

(b) An unusual feature of the C.E.N.T.O. training scheme, not so far mentioned, is that manufacturers took a hand in establishing it. British manufacturers, jointly through their Trade Association, contributed free of charge tractors and other equipment to a value of around £50,000 together with an estimated twelve months' supply of fast-moving spare parts. They are also actively represented on the governing body. In what is now proposed one manufacturer, whether from Britain or elsewhere, might be induced to co-operate rather differently by (1) providing equipment on reasonable credit terms; (2) ensuring, through a local distributor, adequate on-the-spot service and spares facilities; (3) providing, by secondment, two men of ability as Chief Instructors; and (4) keeping in close touch with the progress of the venture through visiting representatives.

(c) In theory, to choose one manufacturer rather than another might be embarrassing. In practice, it need be no more difficult than choosing one rather than another to buy from. If several different manufacturers were equally ready to co-operate, there might be several schemes in different areas.

39. There is no need to go into great detail here. But once established on flexible lines a venture on these lines could accommodate trainees at all levels: project leaders, non-commissioned officers and drivers; each for an appropriate training period. It could also create within itself pilot schemes of any kind. At any time, groups of students and equipment could be temporarily organized so as to operate as group contractors, as one-man contractors, or as the nucleus of a farmers' machinery-sharing scheme. With manufacturers' interests closely and actively engaged, it might bring about much greater appreciation of the needs of small farmers in less-developed countries as, and where, they actually exist. Starting tentatively in a small way, such a venture might find that it had mechanized the whole area; and must start again elsewhere.

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